mistakable records. The chief operator is thus able, without moving from his chair, to control every electrical circuit and situation of the system, and to stop, start, regulate, or synchronise each unit. He can throw the output of each unit through its transformer to the transmission as if from a single isolated plant, or he can throw the current upon either bus-bar while supplying its transformers from the same or another bus-bar. The experience obtained up to the present in the practical working of the plant has been so successful that it is to be anticipated that other large plants in the future will adopt the same system.

Distribution of Power by the Ontario Power Co.

Two 60,000-volt lines run from the distributing station for six miles to a point on the Niagara River near the town of Queenstown, where they cross the gorge, and connect with the lines of the Niagara, Lockport, and Ontario Power Company delivering power for use in the United States. These lines consist of aluminium conductors 1⅛ inches in diameter, carried on steel towers 55 feet high to the top wire, with an average span of 500 feet. The insulators for this line are of porcelain, and weigh 35 lb. each.

The first of the transmission lines was put into operation on July 7, 1906, and the plans realised at present, and contemplated for the immediate future, in the plant of the Niagara, Lockport, and Ontario Power Co., involve a maximum transmission distance of 160 miles. This distance puts the plant amongst the longest transmissions of the world.

Size of Cables.—There are only three sizes of cables used on the main transmission lines, designated by the company as 3/3, 2/3, and 1/3 respectively. The 3/3 cable is aluminium cable, consisting of nineteen strands, and having a total area of 642,800 cir mils, being equivalent to 400,000 cir mils copper. The areas of cross-section of the other cables are respectively two-thirds and one-third that of the large one.

It is impossible to enumerate the manifold purposes for which the power is used, but some of the more important are the following:—

Light.—The power generated at this station and sent out over the above-described transmission lines furnishes part or all of the public and private lighting in Niagara Falls, Welland, Stamford, and St. Catherines, Ontario; and Lockport, Depew, West Seneca, Hamburg, Batavia, Rochester, Canandaigua, Auburn, Baldwinsville, Phœnix, Fulton, and Syracuse, New York.

Heat.—The same power operates electric furnaces for the reduction of iron, copper, and other ores, and the manufacture of cement, calcium carbide, and lime nitrates in Port Colborne, Welland, Niagara Falls, and Thorold, Ontario, and Lewiston, Lockport, and Caledonia, New York.

Power.—The same power operates wholly or in part the trolley systems in Syracuse, Rochester, Canandaigua, Geneva, West Seneca, and Hamburg; and the interurban lines Syracuse, Lake Shore and Northern Syracuse and South Bay, Rochester and Geneva, Rochester and Mount Morris (Erie Railroad), Buffalo, Lockport and Rochester, Buffalo and Hamburg, and Buffalo and Dunkirk (partly constructed). It operates the steel works of the Ontario Iron and Steel Company at Welland, Lackawanna Steel Company (7000 employees), Shenandoah Steel Wire Company, plate-rolling mills of Seneca Iron and Steel Company, and pumping works of Depew and Lake Erie Water Company at West Seneca; repair shops of the New York Central and Hudson River Railway Company, and Delaware, Lackawanna and Western Railroad Company, and the works of the Gold Coupler Company at Depew, stone-crushing establishment of the Kelley Island Lime and Transport Company at Akron; works of the United States Gypsum Company at Oakfield, and various smaller industries located on main transmission lines.

The utilisation of a portion of the vast energy of Niagara without in any way detracting from the splendour or beauty of the Falls is destined to create in the Ontario peninsula and in western New York a vast manufacturing district.

SCIENTIFIC WORK OF THE SMITHSONIAN INSTITUTION.

THE report of Dr. Charles D. Walcott, secretary of the Smithsonian Institution, for the year ending June 30, 1909, has just been issued. All the numerous departments of the institution's activity receive attention, but it is possible here to deal only with the more direct scientific work accomplished during the year under review. Subjoined is a summary of the parts of the report dealing with matters of scientific interest.

Smithsonian African Expedition.

Through the generosity of friends of the institution, there was provided during the year a special fund to pay for the outfitting and to meet the expenses of the naturalists on a hunting and collecting expedition to Africa under the direction of Colonel Theodore Roosevelt. No part of the fund was derived from any Government appropriation or from the income of the institution. The special interest of the institution in the expedition is the collection of biological material for the United States National Museum.

The party sailed on March 23, 1909, from New York, whence steamer was taken to Mombasa, British East Africa. The expedition arrived in Africa on April 21. A letter, dated at Nairobi, May 31, announced the shipment of twenty barrels of large mammal skins in brine, comprising Colonel Roosevelt's first month's collection. While no new species, so far as is known, is included in this first shipment, the collection will supplement materially the specimens already in the National Museum. Together with this shipment are expected a large number of specimens of small mammals, and also of birds. Through the Smithsonian African expedition the National Zoological Park has been presented with an exceptional collection of live African animals.

Cambrian Geology and Palaeontology.

Dr. Walcott's studies of the older sedimentary rocks of the North American continent, which he has been carrying on as opportunity offered for more than twenty years, were continued in Montana and the Canadian Rockies during the field season of 1908. The scientific results of the 950-mile trip through the forests and on mountain trails will aid materially in the solution of several problems connected with the stratigraphy and structure of the main ranges of the eastern Rocky Mountains and of the geological position and age of many thousands of feet of the sandstones, shales, and limestones forming the mountains in northern Montana, British Columbia, and Alberta. On the return an examination was made of the geological formations in the vicinity of Helena, Mont., and of the Wasatch Range, south-east of Salt Lake City, Utah. Three additional papers giving a summary of the results of these studies in Cambrian geology and palæontology were published during the year.

Researches on Atmospheric Air.

A Hodgkins grant was approved in October, 1908, for the erection of a small stone shelter on the summit of Mount Whitney, California, for the use of investigators during the prosecution of researches on atmospheric air, or on subjects closely related thereto. The pioneer trip to the summit of Mount Whitney in the summer of 1881 by the late secretary, Dr. Langley, at that time director of the Allegheny Observatory, will be recalled in this connection, as well as his conviction that in no country is there a finer site for meteorological and atmospheric observations than Mount Whitney and its neighbouring peaks.

Mr. C. G. Abbot, who succeeded Secretary Langley as director of the astrophysical observatory of the Smithsonian Institution, and to whose immediate suggestion and earnest personal efforts the preparation for and the establishment of this important post on Mount Whitney are largely due, began his observations there in the summer of 1909, and obtained important data in the determination of the solar constant. The cooperation of Prof. W. W. Campbell, the director of Lick Observatory, University of California, at Mount Hamilton, has been most helpful during the erection of the shelter. The class of researches to be prosecuted at this exceptionally favourable station are not only of great scientific interest, but are expected also to prove of value in determining questions having a direct, practical influence on the preservation and progress of human life on our globe.

International Standard Pyrheliometers.

A limited grant from the Hodgkins fund was approved in February, 1909, for the construction of several silver disc pyrheliometers. These instruments are to be placed in charge of scientific investigators in widely separated localities for the purpose of establishing an international scale for the comparison of observations on solar radiation. The varying results published by observers have made the need of international cooperation in this connection apparent, and the matter has received considerable attention at conferences of the Solar Union. These simple and comparatively inexpensive instruments are to be constructed after a design by Mr. Abbot. Similar pyrheliometers have been employed in the researches of the Astrophysical Observatory for several years, and have proved entirely satisfactory.

Langley Medal and Memorial Tablet.

As a tribute to the memory of the late secretary, Dr. S. P. Langley, and his contributions to the science of aërodromics, the regents of the institution adopted the following resolution on December 15, 1908:—"That the board of regents of the Smithsonian Institution establish a medal to be known as the Langley medal, to be awarded for specially meritorious investigations in connection with the science of aërodromics and its application to aviation." Following the establishment of this medal, a committee of award, composed of gentlemen of recognised attainments in the science of aërodromics, was appointed. The committee recommended that the first medal be bestowed on Messrs. Wilbur and Orville Wright, and the medal was awarded on February 10, 1909. Designs for the Langley memorial tablet are now being prepared by a well-known architect of Washington.

National Museum.

More than 250,000 specimens were added to the museum collections during the year, about 200,000 of them pertaining to biology and the remainder to geology and anthropology. One of the most important additions to the division of ethnology was a contribution from Dr. W. L. Abbott, consisting of about 500 objects from south-western Borneo. To the technological collections were added more than 200 objects transferred from the United States Patent Office. The department of biology received a noteworthy gift of about 1200 European mammals and sixty-one reptiles from Mr. Oldfield Thomas, of the British Museum, and Mr. Gerrit S. Miller, of the National Museum. This has so greatly increased the importance of the National Museum collection of the mammals of Europe that it now ranks as one of the largest and most valuable in the world. Mention must also be made of a contribution of about a thousand mammals and birds of Borneo, received from Dr. W. L. Abbott.

In connection with the work of excavation and repair of the Casa Grande ruins in Arizona, under the direction of the Smithsonian Institution, there were collected and placed in the National Museum about 650 stone axes and hammers, rubbing and grinding stones, earthenware bowls and vases, pieces of basketry and textile fabrics, shell ornaments, and wooden implements. From similar excavations in the Mesa Verde National Park, Colorado, there were received about 500 objects of like character. The department of geology received a large series of Cambrian fossils from the Rocky Mountains, collected during Dr. Walcott's field studies in that region. There were also added to the collections many objects pertaining to mineralogy and palæobotany. Eighty-two regular sets of geological specimens to the number of 7739 were distributed during the year for educational purposes, besides 1300 specimens of geology, marine invertebrates, and fishes arranged in special sets.

Two field parties in which the institution and museum are greatly interested left America during the year for important collecting regions, from both of which valuable results may be expected. The first will explore Java and some of the adjacent islands; the second expedition is that under the direction of Colonel Theodore Roosevelt into British East Africa and more inland districts.

Bureau of American Ethnology.

The bureau has collected data relating to sixty families or linguistic stocks and upward of 300 tribes. It does not expect to study all the tribes in detail, but rather to investigate a sufficient number as types which may stand for all. It has seemed wise at this stage of the researches to prepare a summary of our knowledge of the tribes, and this has taken the form of a "Handbook of the Indians," of which one large volume is published and the second nearly through the press.

The people of the United States have two great obligations which the bureau is trying to fulfil:—(1) that of acquiring a thorough knowledge of the Indian tribes in the interests of humanity; (2) that of preserving to the world an adequate record of the American race which is so rapidly disappearing.

Recently much interest has been manifested in the antiquities of the country, more especially in the great pueblo ruins and cliff dwellings of the arid region, and the fifty-ninth Congress enacted a law for the preservation of these antiquities. A first step in making this law effective is their exploration. A second is the excavation and repair of the more important ruins to ensure their preservation and to make them available to the public and for study. Dr. J. Walter Fewkes, of the bureau, has continued the work of excavation and repair of the ancient ruins in the Mesa Verde National Park. During the year the repair of Spruce Tree House was completed, and at the end of June excellent progress had been made in uncovering and repairing the crumbling walls of Cliff Palace, the greatest of the ancient ruins of its kind in the United States.

There is need also for ethnological work in the Hawaiian Islands and Samoa, for the following reasons. It is regarded as most important that the Government should have definite and detailed information regarding the native inhabitants of these islands, which are under its control and for whose welfare it is responsible. It is not less a duty of the nation to preserve some record of this peculiar race for the purposes of history and science, as neglect will become a source of deep regret. An experienced ethnologist should make investigations regarding the history, social institutions, religion, and general culture of the people, and a physical anthropologist should study their physical and mental characteristics.

National Zoological Park.

The National Zoological Park during the year added 576 new animals to its collections, which offsets a loss of 562 by exchange, death, and return of animals, and brings the number of individuals on hand, June 30, 1909, up to 1416. The entire support of the park was derived from an appropriation of 19,000*l.* for general purposes, including the purchase, transportation, care, and maintenance of animals; the care and improvement of grounds; the construction and repair of all buildings, enclosures, roads, walks, and bridges. Of this amount, the increased price of necessary provisions and labour brought the cost of maintenance alone to about 17,000*l.* It was therefore possible to do little toward permanent construction or improvement.

Astrophysical Observatory.

The work of the Astrophysical Observatory during the year consisted:—(1) Of bolometric observations carried on at Washington on the brightness of different parts of the sun's image; also some experimental work on the transparency of the air for long-wave rays, such as the earth radiates. A computation of the results of these experiments is now far enough advanced to show their satisfactory quality. Precise knowledge of the selective absorption of our atmosphere for earth rays is still lacking, and contradictory views are still being expressed about this important subject; hence it is hoped that these experiments will be useful in the study of the dependence of the earth's temperature on radiation.

(2) Spectrobolometric measurements of the solar constant of radiation have been continued at the Mount Wilson Observatory in California. As in former years, evidences of a fluctuation of solar radiation were found in the results of the measurements thus far obtained. A new and improved standard pyrheliometer was found to be more satisfactory than the one used in 1906, and great confidence is felt in the results obtained with it. Efforts have also been made to carry the bolometric measurements much farther in the ultra-violet through the use of a large quartz prism, a large ultra-violet glass prism, and two magnalium mirrors.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The special board for biology and geology has appointed Mr. Leonard Doncaster, of King's College, to be superintendent of the Museum of Zoology, and the Vice-Chancellor has approved of the appointment.

GLASGOW.—Principal Sir Donald MacAlister, K.C.B., has been appointed to represent the Senatus of the University at the centenary festival of the University of Berlin in October next.

A scheme for the formation of a clinical branch of the medical school of the University, to be situate at the Royal Infirmary, was approved by a Parliamentary Commission, after a two days' hearing, on April 1. The provisional orders for the purpose contemplate the establishment of four professorial chairs at this infirmary, in addition to those held at the Western Infirmary, namely, those of medicine, surgery, obstetrics, and pathology. The necessary funds, amounting to about 2000*l.* a year, are provided for from existing endowments and by grants from St. Mungo's College, the Muirhead trustees, and other benefactors. All the instruction thus provided will be open to women students of the University as well as to men.

THE late Colonel G. E. Church, who died on January 4, bequeathed 1000*l.* to the Royal Geographical Society towards a fund for the enlargement of its premises or towards a new building for its use. He left to Harvard University his collection relating to North and South America, consisting of books of travels, voyages, explorations, boundary-line questions, geography, ethnology, and history, as well as all writings by Latin and American authors, to be known as the "George Earl Church Collection." Should the authorities of the University not accept this gift within four months of his death, then the collection is to be offered to the Brown University, Rhode Island, or the Stanford University, in California.

IN Class iv. (Education, Science, and Art) of the Civil Service Estimates for the year ending March 31, 1911, the estimate amounts to 18,651,483*l.*, a net increase of 697,718*l.* on the amount voted in 1909. The estimate for the Board of Education shows a net increase of 417,663*l.*, of which 348,775*l.* arises under the subhead of grants in respect of public elementary schools, &c. A sum of 200,000*l.* is again provided for special grants to certain necessitous local education authorities. The estimate for scientific investigation, &c., includes a grant of 7500*l.* in aid of the expenses of the aëronautical section of the National Physical Laboratory, and a grant of 20,000*l.* in aid of the expenses of the British Antarctic Expedition of 1910.

THE following courses of free advanced lectures have been arranged by the University of London:—a course of five lectures on "Fertilisation and Related Phenomena," to be given by Prof. J. B. Farmer, F.R.S., at the Royal College of Science, on Wednesdays at 5 p.m., beginning on April 27; a course of five lectures on "The Anatomy of Plants in Relation to External Conditions," to be given by Mr. L. A. Boodle at University College on May 26, May 30, June 2, June 6, and June 9, at 5 p.m. A course of three lectures on "The Geology and Geography of Charnwood Forest" will be given by Prof. W. W. Watts, F.R.S., at the Imperial College of Science and Technology, on Mondays at 5 p.m., beginning on April 25. The lectures are addressed to advanced students of the University and to others interested in the subjects. Admission is free, without ticket.

THE difficulty of reaching the cultivator of the soil for any educational purpose has not as yet been overcome in any country, and certainly not here. Some interest, therefore, attaches to a scheme that has been at work in the West Indies for about eighteen months, and has proved so effective that it is to be adopted permanently. Courses for home reading are drawn up, divided into three parts, at the end of each of which are held examinations known respectively as the preliminary, the intermediate, and the final. The preliminary examination requires a general all-round education, and is dispensed with in the case of students who possess certain qualifying certificates. The intermediate examination requires such knowledge of the general principles of agriculture, and of planting work in particular, as might be expected from an intelligent overseer of a few years' experience, while the final examination reaches the standard necessary for a man capable of managing an estate. A leaflet is issued by the West Indian Agricultural Department containing a syllabus of the subjects necessary for each part, with hints as to what books should be read. In addition, the *Agricultural News*, the fortnightly paper issued by the Department, devotes nearly a page in each issue to notes bearing on the current work of the estate, thus giving the necessary practical illustrations of the general principles set out in the text-books. A few questions are also set which students are advised to attempt. The Department, however, does not set up to act as a correspondence college and correct the answers to the questions. It is left to the student to find someone who will discuss his work with him and help him over those hard places where a man, reading on his own account without any assistance, inevitably gets stranded sooner or later. At first the officers of the Department gave a good deal of help by organising students' meetings where difficulties could be discussed; voluntary workers also came forward. The examinations are conducted by the staff of the Department, acting in conjunction with some of the planters. The intermediate and the final are essentially technical in their nature; the candidate is expected to be a better man at field or plantation work as a result of his reading, and he must demonstrate his superiority to the satisfaction of the planters on the examining board. In this way the interest and sympathy both of masters and of men can be enlisted, and both are brought to realise that the certificates awarded indicate increased efficiency on the part of the holder. Interest in the scheme is said to be spreading among the cultivators, while the organisers have found certain modifications that will still further increase its utility. It will be carefully watched by those in this country who are engaged in elementary agricultural education.

THE National Union of Teachers held its conference this year at Plymouth during Easter week. Naturally, most of their discussion was confined to various aspects of elementary education, but other subjects of national importance were also considered. Mr. Marshall Jackman, the president, was chiefly concerned with a demand for more money from the Treasury for elementary education, to relieve the financial straits in which many local education authorities find themselves. Mr. Jackman contended that we build Dreadnoughts regardless of cost, not because we want them, but because we feel the necessity of keeping pace with our neighbours. If we could have a similar cry in education to the Two Power standard cry for the Navy we should be able to do much for educational progress. He set out a national educational standard which he thought was worthy of this great Empire. Is it too much to demand that the educational opportunities for British boys and girls shall be no less than those for the children of any other nation? His new standard was that all forms of education should be as free to the British child as to the American child, the elementary schools of Britain should be manned by teachers no less efficient than those in the schools of Sweden, the classes of the schools in Britain should be no larger than those of Den-